Currents of Ocean

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AN

ESSAY

ON

CURRENTS at SEA;

By which it appears,

There is Reaſon to apprehend, that the SEA is not a FLUID in a STATE of REST, except thoſe MOTIONS which are cauſed by the IMPULSE of WINDS, and that known by the Name of TIDES:

And conſequently,

That this EARTH is not of a uniform Denſity, according to the Suppoſition of Sir ISAAC NEWTON; but that the CURRENTS of the Gulph of *FLORIDA*, alſo on the Coaſt of *BRASIL*, and the Northern In-draught on this Weſtern Coaſt, are Currents of Circulation, kept up by different Denſities in this Earth, and its Motion round its AXIS.

By JOSEPH MEAD.

LONDON:

Printed for J. MARSHALL, in St. *Clement's Church-Yard*, in the *Strand*. M,DCC,LVII.

ERRATA.

P. iv. l. 28. for Sea's being in a Fluid, read Sea's being a Fluid. P. v. l. 28. for Guph, read Gulph. P. 13. l. 26. for difference Diſtances, read different Diſtances. P. 36. l. 21. for *Fewfoundland*, read *Newfoundland*. P. 39. l. 12. for Solar Heart, read Solar Heat. P. 39. l. 28. for Vegatation, read Vegetation.

THE

PREFACE.

WERE an Art, or Science, to be more or leſs regarded, as it aſſiſted in the Preſervation of the Lives and Properties of ſome uſeful Members of a Community; in the Defence of our happy Conſtitution; or in the Accumulation of Wealth; it is probable, that *Navigation* might not be thought unworthy of the higheſt Eſteem.

If we were to attempt to make any uſeful Diſcovery, in an Art of ſuch great Utility to the Publick, I don't know that there could be any Method put in Practice that would promiſe greater Succeſs, than firſt to conſider in what Part or Parts we had been deficient, or had met with Loſſes, *&c.* than to endeavour to diſcover the Cauſe or Cauſes thereof, for the better enabling us to provide againſt the like for the future.

Had there been an exact Account kept of the many Losses and Disappointments which have happened, by Ships falling into the Northward of what they had Reason to expect from their Reckoning; from which some of the * Royal Navy have not been exempt, it is not to be doubted, but they would extend beyond Imagination; and what may be thought to make the Loss of some of such Unfortunate as have suffered the more to be regretted is, that their Misfortunes seem to have been brought on them, by adhering strictly to what has been taken up for a Principle, which it is not unlikely will appear erroneous. I mean, that of *the Sea being a Fluid in a State of Rest, except what Motion is caused by the Impulse of Winds, and that known by the Name of Tides.* For it is obvious, if a Reckoning at Sea is kept on that Principle; and a Northern In-draught at the same Time, without any Opportunity of taking an Observation for several Days, to correct such Reckoning: Under similar Circumstances, if a Ship should be running in with this Western Coast, it must be attended with a dangerous Consequence. A particular Instance of which shall endeavour to repeat, as I had it from the Com-

* *October* 22, 1707, in the Night, Admiral *Shovel*, in his own Ship the *Association*, with the *Eagle*, and *Romney*, were dashed to Pieces upon the Rocks, called the *Bishops and his Clerks*, and all their Men lost; the *Firebrand* was also cast away, and but twenty-four of her Men saved. *Salmon*'s Chronology.

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mander of a Merchant Ship that was loſt, who was allowed to be a Seaman of good Repute in the Port of *Liverpoole*.

It was in the Month of *November*, or Beginning of *December*, in or near the Year 1735, the *Hope*, of and bound for *Liverpoole*, from the River *Sherbro* on the Coaſt of *Guinea*, with Camwood and ſome Elephants Teeth, had a good Obſervation, by which they found they had the North Channel open; the Wind continued to blow ſtrong between the South and Weſt, but moſt inclined to the former. Having no other Obſervation for about ſix Days, in which Time they carried Sail continually. Then by their Reckonings, they judged they ſhould fall in with *Cape Clear*, on the South Weſt Coaſt of *Ireland*, or to Windward thereof; but in the following Night they fell in with the Horſe Rock to Weſtward of the *Blaſques*; and were ſo near, that in wearing Ship (to ſtand to the Weſtward) the Sea was reverberated from the Rock on board their Ship. In the Morning they ſtood in for the Land, and made it; but being unacquainted with thoſe Parts, they could not tell what particular Land it was. Afternoon the Wind veered more Weſterly, their Ship being very foul, and having ſtrong Gales, with a great Sea from the Weſtward, thought it impracticable to keep the Ship off the Shore till Day-light next Morning, by carrying the greateſt Sail the Ship, *&c.* could bear. Therefore, under theſe diſagreeable Circumſtances, judged it to be the moſt prudent

(for the Safety of the whole) to endeavour for a Harbour. They run into a ſmall Bay within the *Blaſques*, which to outward Appearance was a Harbour, but proved only fit for Boats, *&c.* where they ſaved themſelves and Cargo, at the Expence of the Ship. At firſt it was thought their Compaſſes had been in Fault, but on Examination the Defect was not there.

From this Account, and taking particular Notice of a Northern In-draught when Opportunity ſerved, can find no manner of Reaſon to doubt, if we were to enquire further of ſuch as have ſuffered, for want of an Opportunity of taking Obſervations; but we ſhould find they were carried to the Northward in a like inſenſible manner.

In order to obtain the cleareſt Inſight I poſſibly could, into the Cauſe of the ſeveral Misfortunes which has happened by Ships falling into the Northward, have firſt conſidered a Part of the learned Dr. *Halley*'s Directions for ſailing into the *Engliſh* Channel; and how it differs from ſuch Practice of ſailing into the *Engliſh* and *Briſtol* Channels, as is conſiſtent with Safety. Next have endeavoured to ſhew how inſufficient the Authority appears for what has been admitted as a Property of the Sea; that is, *the Sea's being a Fluid in a State of Reſt, except ſuch Motions as are cauſed by the Impulſe of Winds, and another known by the Name of Tides.* And have afterwards endeavoured to account for the Reaſons which might induce ſome to believe, that that was an inſe-

parable

parable Property of the Sea. Then have conſidered particular Gravity of ſeveral Parts of this Earth, according to Sir *Iſaac Newton*'s Suppoſition of this Earth being all of a uniform Denſity; alſo the Shape thereof cauſed by its Motion round its Axis. But as there appears no ſolid Foundation for the Suggeſtion of a uniform Denſity of this Earth, I have formed the Hypotheſis of a Circulation of the Sea, upon the Increaſe of Gravity from the Equator to the Poles, which has been confirmed by Experiments made with Pendulums; by which it may probably appear, that if there are ſubterranean ſubmarine Caverns of Communication from Places in high Latitudes to Places near the Equator, this Earth may have ſuch different Denſities in different Parts thereof, that by its Motion round its Axis may cauſe the Sea to have a Circulation thro' them, by entering in at thoſe Ends of the Caverns which are nearer the Poles, and riſing at the other Ends which are nearer the Equator, then conſequently deſcending from the Equator towards the Poles on the external Parts; which would be a Circulation, and produce ſuch a Current as the Right Honourable Lord *Anſon* has found on the Coaſt of *Brazil*; alſo alike to the Guph-ſtream, and to the Northern Indraught, that is obſerved on theſe Weſtern Coaſts.

But although forming Hypotheſis on Suggeſtion, is ſometimes of the greateſt Service in making Diſcoveries, in the wonderful and beautiful

tiful Operations of Nature; yet, if we ſhould allow every Thing to be Fact, which Theory or Suppoſition admits of, the Mind might be involved in a Multitude of Errors; whereas when Phenomena is found to agree with Hypotheſis, it is allowed to be the higheſt Preſumption in Favour thereof. Therefore have conſidered the ſeveral Phenomenon, that ſuch a ſuppoſed Circulation might probably produce; and have then made my Enquiries into the Appearances of Nature, and have found agreeable thereto, 1*ſt*, 2*dly*, and 3*dly*, the Whirlpools of *Maleſtream*, at the *Ferræ* Iſlands, and *Forbiſher*'s *Streights*; alſo the riſing of the Sea-water within the Torrid Zone; and the great Quantity of Sea Vegetables, known by the Name of Gulph Weed, to favour the Hypotheſis of the Sea having a Circulation.

4*thly*, 5*thly*, and 6*thly*, Have conſidered the Currents within ſome Parts of the Torrid Zone gravitating towards the Temperate Zones; alſo the Currents in the Temperate Zones gravitating towards the Poles. And the greater ſaltneſs of the Sea within the Torrid Zone (in ſome Parts of which the Sea-water is obſerved to riſe) than that of Parts of the Sea in high Latitudes; as Appearances of Nature ſufficient to further countenance the Hypotheſis of the Sea's having a Circulation.

7*thly* and 8*thly*, Have conſidered ſome Properties of Air, as its being rarified by Heat, and condenſed by Cold, as ſet forth by Mr. *Boyle* and Mr. *Robins*, Fellows of the R. S. for the better

ter judging of Sea Breezes, ſo far as they might indicate a Circulation of the Sea. Alſo the greater Heat of the Temperate Zones, for ſome Months in the Year, than any Heat of our Iſlands within the Torrid Zone, although the latter have the Sun vertical twice every Year; which appears to agree with what has been thought requiſite, to further favour the Hypotheſis of the Circulation of the Sea.

9thly, Have conſidered the Motion of the Northern internal Magnet of theſe Kingdoms, as diſcovered by the beſt Obſervations which I could procure of the Dipping Needle from Mr. *Norman*'s in 1576, to Mr. *Whiſton*'s in 1721; by which our great Northern Magnet appears to have a Southern, as well as a Weſtern Motion, which agrees with Hypotheſis, and what might further be expected if the Sea had a Circulation, as it probably may not be known, that there is any Example in Nature of Terreſtrial Matter being moved continually for a Number of Years, except by Currents of a liquid Fluid. Therefore have thought, that the Agreement of ſo many Appearances of Nature with Hypotheſis, might not be thought inſufficient to alledge, that the Sea has a Circulation. But if thoſe ſhould not be thought concluſive, as Nature is known to be the moſt excellent in all its Operations; the cooler Regions ſupplying cooler Springs, and aſſuaging the ſcorching Heat of the Torrid Zone; and the ſame Fluid abſorbing the greater Part of the Redundance of that ſolar Heat, and

and gravitating with it with a slow Motion, and warming the Sea-coasts of the cooler Regions, appears so consistent with that magnificent Harmony and Perfection which may be observed through the Course of Nature; and the Benefits to Animal and Vegetable Life, which may probably appear to arise therefrom, are so much superior to any Thing that can be expected from *The Sea's being a Fluid in a State of Rest, except such Motions as are caused by the Impulse of Winds, and that known by the Name of Tides*; that they might be thought not an insufficient Support, if there were no other to favour the Hypothesis of the Sea's having a Circulation.

Indeed, had it been attempted in a Language suitable to the Importance of the Subject, it would have been much more agreeable to my Wishes, as well as to the Reader. But when the Advantages which may attend a new Discovery in Nature, and the few Opportunities, as well as Inexperience of most of the Learned, to make Observations on Currents at Sea are thoroughly considered, I flatter myself, that my Endeavours to proceed in a plain Way may not prove unacceptable.

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AN

ESSAY

ON

CURRENTS at SEA.

ALTHOUGH, from the earliest Accounts of Navigation, the Opinion has prevailed of the Sea's being a Fluid in a State of Rest, except those Motions which are caus'd by the Impulse of Winds, and that known by the Name of Tides. Yet when those ſtrong Currents on the Coaſt of * *Brazil*, which are mentioned by the Rev. Mr. *Walter*; alſo the ſtrong Current in the Gulph of *Florida*; and the many Loſſes and Diſappointments which theſe Kingdoms have ſuſtained, by Ships falling into the Northward, when deſigned for the Channel: I ſay, when theſe are thoroughly conſidered, I don't queſtion, but it may appear, the Sea has a Motion from ſome natural

* Lord *Anſon*'s Voyage, p. 53.

Cauſe or Cauſes, that hath not been to this Time diſcovered.

Agreeable to this Opinion of the Sea being a Fluid in a State of Reſt, *&c.* the learned Dr. *Halley*, in his * Directions for Sailing into the *Engliſh* Channel, ſays, the Variation being allowed, the Northern In-draught is inſenſible. But, I muſt beg Leave to obſerve, that the *Briſtol* Merchantmen, which fall in with Cape *Clear* in their homeward bound Paſſage, in ſhaping their Courſe, with a large Wind from the Coaſt of *Ireland*, to the high Land near *Padſtow*, which is the Land they chuſe to make: That their Practice for ſome Years hath been to allow † two Points for the Variation and In-draught into St. *George*'s Channel. Of this Allowance of two Points, which is 22° 30′, four or five Degrees muſt certainly be for Northern In-draught, as the magnetical Variation at this Time may be preſumed to be not more than ſeventeen or eighteen Degrees in that Channel: And as this Allowance is made in Sailing from Land to Land, it doth not appear to admit of any Deception, but that the four or five Degrees muſt be adequate to a Northern In-draught.

If there ſhould be an Enquiry made into the Practice of Sailing into the *Engliſh* Channel, I don't doubt, but that every diſcerning experienced Seaman would acknowledge, that the Safety of their Ships, *&c.* after they came into Soundings, to the Time they reached the Length of *Scilly*, depended on their making no leſs Allowance than the *Briſtol* Men does, from the South Coaſt of

* *Engliſh* Pilot, Part I. p. 32.

† This Account I had from a Merchant of *Briſtol*, who at my Requeſt was ſo obliging, as to enquire of ſeveral Maſters of Merchantmen which belonged to that Port.

Ireland

Ireland to the high Land near *Padſtow*. Should any Gentleman, *&c.* condeſcend to aſk my Opinion of a Northern In-draught, I ſhould anſwer, that Experience informed me, that from Commencement on Soundings in the Latitude of 49°, 30′ North, to the Length of *Scilly* in fair Weather, I had found the Northern In-draught to be about ſix or eight Miles in twenty-four Hours; that on the Weſt Coaſt of *Ireland*, off the Shellocks, *&c.* it was not leſs than four Leagues in twenty-four Hours, even when there was moderate Northern Gales: Alſo off the Weſt Coaſt of the *Lewis* Iſlands, I had found it ſtronger than in Soundings, and alſo of *Foule* Iſle to the Weſtward of *Sunborough Head*, *Shetland*, I had obſerved a Northern In-draught ſomething weaker than the latter.

If we ſhould deſire to know what Authority we had for this Opinion of the Sea being a Fluid in a State of Reſt, *&c.* would it not appear that the firſt reputed Seaman, of the latter Ages, were *Portugueze*, *Spaniards*, &c. who, we are aſſured, were not very expert in their Profeſſion, as there has been * great Improvements made here in Na-

* Mr. *Robert Norman*, of this Kingdom, who was the firſt that found the Inclination of the Magnetick Needle below the Horizon, and invented the Dipping Needle, in his New Attractive, which might be publiſhed about the Year 1580, ſays it was then the Cuſtom to have the Magnetick Needle placed in ſuch Manner on the Compaſs Chart, as it would allow for the Magnetick Variation of thoſe Places where they belonged to: This Practice is retained by ſome of the Coaſters of *Normandy* to this Day, there being ſome Compaſſes of that Sort, taken from the *French* in the late War. Mr. *Gellibrand*, of this Kingdom, is ſaid to be the firſt Diſcoverer of the Motion of the Internal Magnet: And Mr. *Wright*, of this Kingdom, is ſaid by ſome Authors to be the firſt Projector of the Chart which has the Name of Mercator's, and to be the firſt Inventor of the Sailing, which is known by the ſame Name. And as to Inſtruments for taking the Sun's Altitude, there are ſcarce any made uſe of but ſuch as were firſt invented in this Kingdom.

vigation and Sailing ſince that Time. Now as it would be an Affront to a Seaman of theſe Kingdoms, to have any Practice of thoſe Nations in Marine Affairs offered as a Precedent, Pray is it more reaſonable that we ſhould accede to, or adopt implicitly, the Opinion of the Sea being a Fluid in a State of Reſt, except thoſe Motions which are cauſed by the Impulſe of Winds, and that known by the Name of Tides, when there appears ſome Reaſon to believe to the contrary?

The Difficulties which have appeared to ſome, to account for theſe Currents, who only conſidered them ſuperficially probably, aroſe from their taking it for granted, that this Terraqueous Globe had no other Mechaniſm in the Structure, than what might be expected from a very large Fiſh Pond; that is, the Land, *&c.* raked out and laid in Heaps and Patches, to make Room for the Water: But if we conſider this Earth's Motion round its Axis, and apply that Motion to ſome Part of Sir *Iſaac Newton's* Theory, but not of his Suppoſition of a uniform Denſity of every Part of this Earth, I think ſuch an Hypotheſis may be formed, as may not only help to explain the probable Cauſe of many Currents, but likewiſe of ſome other ſurpriſing Appearances of Nature, which have not yet been properly accounted for. In order to proceed, I ſhall beg Leave firſt to conſider ſome Properties of particular Gravity.

I. All circumterreſtrial Bodies do hereby tend towards a Point, which is either accurately, or very near the Center of Magnitude of the Terraqueous Globe.

II. In all Places equidiſtant from the Center of the Earth, the Force of Gravity is nearly equal, indeed all Places of the Earth's Surface are not at equal Diſtances from the Center, becauſe the Equatorial

Equatorial Parts are higher than the Polar Parts; the Difference between their Diameter being * forty one and a half *Engliſh* Miles.

III. † The Force of Gravity conſidered downwards from the Surface of the Earth, decreaſes nearly, in the Proportion of Diſtances from the Center; the Error being no greater than what may ariſe from Inequalities of the Denſity of different Parts thereof.

Then if a Body in Vacuo near the Surface of the Earth, ſhould deſcend ſixteen Feet in a Second of Time, a Body equally diſtant from the Center, and the Surface, would deſcend but eight Feet in a Second of Time, and at a fourth Part of the Diſtance from the Center, to the Surface, would deſcend but four Feet in a Second of Time: Or if we ſhould ſuppoſe a Body at the Earth's Surface to weigh 16 Pounds, the ſame Body at a Place equally diſtant from the Surface and the Center, would weigh but eight Pound, and at a fourth Part of the Diſtance from the Center to the Surface, would weigh but four Pounds; or at Three-fourths of the Diſtance from the Center to the Surface, the ſame Body would weigh twelve Pounds.

As attractive or gravitating Force has been conſidered at difference Diſtances from the Earth's Center, I ſhall next proceed to Centrifugal Force. It is by Centrifugal Force, that a Body revolving round its Axis endeavours to recede from it: It is by this Force, that the Earth's Diameter at the Equator, is greater than at the Polar Axis. Philoſophers have deſcribed it nearly in the following Manner.

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* Dr. *Bradley*'s Acc. Philoſ. Tranſ. N° 432.

† Sir *Iſaac Newton*'s Meth. Princ. of Nat. Philoſ. by *Motte*, vol. II. b. III. p. 229.

Let

Let Figure 1 repreſent the Earth; let *PP* be the Axis at the Poles *EE*, the Diameter at the Equator, perpendicular to the Axis: Let there be ſuppoſed a Canal to the Center of the Earth *PCE*, filled with a Liquid, this Fluid will deſcend by its Gravity in both Legs towards *C*, and will not be at reſt till the Preſſure at both Legs be equal, if the Earth be at reſt; but if the Earth be moved about its Axis *PP*, all the Liquid in the Leg *CE* will endeavour to recede from the Center, by its Centrifugal Force; which Force in that Part acts directly contrary to Gravity; ſo that there is no Equilibrium till *CE* exceeds *CP* 20½ Miles, that being the Quantity, the Semi-diameter of the Equator exceeds the Semi-diameter of the Poles; but this is all on the Suppoſition of the Earth's being all of a uniform Denſity.

The next Effect of Centrifugal Force, and this Figure of the Earth is, that Pendulums of the ſame Length, does not in different Diſtances from the Pole, make their Vibrations in the ſame Time; but towards the Pole, where the Power of Gravity is ſtrongeſt, they move quicker than near the Equator, where they are leſs impelled to the Center. For ſince, from the Rotation of the Earth about its Axis, every Body endeavours to recede from the Center of the Circle it deſcribes, by how much the greater thoſe Circles are, by ſo much is the Centrifugal Force of the Bodies deſcribing thoſe Circles increaſed; which Force is therefore always as the Sine of the Diſtance from the Pole, which as it is greateſt under the Equinoctial, is nothing at all under the Pole; ſo that the Force of Gravity is the leaſt under the Equator, but at the Pole the greateſt.

This Increaſe of Gravity from the Equator to the Poles, hath been confirmed by ſeveral Experiments

ments made with Pendulum Clocks, at different Times and Places. In 1672, in the Iſland of *Cayenne*, by M. *Richer*. In 1677, in the Iſland of *St. Helena*, by the learned * Dr. *Halley*: And in 1682, by M. *Varin*, and M. *Des Hayes*, at the Obſervatory at *Paris*; in the Iſland of *Goree*, and at the Iſlands of *Martinico* and *Guarda Coupe*; alſo by ſeveral others at different Times and Places. But the moſt accurate Obſervations appear to be made in *London*, by † Mr. *George Graham*, F. R. S. and at *Black River* in *Jamaica*, by *Colin Campbell*, Eſq; F. R. S. From which the excellent Dr. *Bradley* hath ſhewn (from Mathematical Reaſoning thereon) the Difference of the Length of a ſingle Pendulum that will keep true Time at the Equator, and at every five Degrees of Latitude from thence to the Poles, alſo the Number of Seconds that a Clock would gain in a Day in thoſe ſeveral Latitudes, ſuppoſing it went true when at the Equator. And likewiſe it appearing that the whole Time of the Swing, when a Pendulum moves thro' ſmall Arches, bears to the Time required for a Body to fall down thro' half the Length of the Pendulum very nearly the ſame Proportion, as the Circumference of a Circle bears to the Diameter; that is, very nearly the Proportion of 355 to 113: It may be ſaid to further illuſtrate the Increaſe of Gravity from the Equinoctial to the Poles.

Now as we are well aſſured, the Increaſe of Gravity, from the Equator to the Poles, hath been confirmed by Experiments, which might have been tranſcribed more fully, if my Intention had not

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* Sir *Iſaac Newton*'s Math. Princ. of Nat. Philoſ. by *Motte*, vol. II. p. 248.

† Philoſ. Tranſ. N° 432, or *Martyn*'s Abridgment, vol. VIII. p. 23.

been

been to uſe all the Brevity that thoſe Subjects would bear, for explaining my Thoughts

It might have been obſerved, that by the former Explanation of a Centrifugal Force by a ſuppoſed Canal, the Water at the two Ends thereof were ſuppoſed to be confined by Land, and the Earth was ſuppoſed to be of a uniform Denſity. But my Intention being to diſcover what a like Canal would produce, on a Suppoſition that the Ends of it was under the Sea, and that the Earth has ſuch different Denſities in the internal Parts, as would favour the Sea's having ſuch Motion, as might be expected by the Increaſe of Gravity from the Equator to the Poles, on ſtatical Principles. And as there are ſeveral Caverns of Communication, from one Part to another of the Earth's Surface, as the River *Niger* is hid by the Mountains of *Nubia*, and riſes again on the Weſtern Side of thoſe Mountains; the *Tigris* is loſt in the Mountain *Taurus*; the *Guediana* in *Spain* riſes in *New Caſtile*, and a little lower is hid for ten Leagues. Therefore it is not a Thought altogether inconſiſtent with Nature, that there may be ſubterranean ſubmarine Caverns of Communication from one Part or Parts of the Sea to others. Nor if there were no ſuch Paſſages from ſome Parts of the Earth's Surface to others: If it ſhould appear that ſubterranean ſubmarine Caverns and Fiſſures of Communication from one Part, or Parts of the Sea, to others, can be of Service to animal and vegetable Life, it may not be thought inconſiſtent with the Perfection of Nature, to admit it as a Circumſtance, if not a Reaſon, to believe there may be ſuch. Therefore in order to diſcover what Effect ſubterranean ſubmarine Caverns of Communication would produce, on ſuch ſuppoſed Principles of favourable different Denſities of this Earth, let

Figure

Figure 2d repreſent the Earth, let *PP* be the Polar Axis, *EE* the Equator, and *C* the Centre: *F*'s and *E*'s repreſent ſome ſuppoſed ſubmarine Caverns of Communication, and the Darts be Sea-water. By the Force of Gravity, being greater at *F*'s than at *E*'s from ſtatical Principles, there will be a continual Deſcent of Sea-water at *F*'s; and the leſſer Force of Gravity being at *E*'s, the ſame Water which deſcended at *F*'s, will be a continual Spring at *E*'s: And it being a Property of all Fluids to endeavour to preſerve an Equilibrium, by the continual Deſcent of the Water at *F*'s, and no leſs Springs at *E*'s, there will be a Decreaſe at the former, and a Redundancy at the latter, by which the Water that Springs at the Ends of ſuch ſuppoſed Caverns, which are near the Equator, will gravitate to the other Ends which are nearer the Poles (the Poles being 20 ¾ *Engliſh* Miles nearer the Center of the Earth than the Equator) and become a perpetual Motion.

It may probably be thought a Preſumption in me, to attempt to form any Hypotheſis, on a Suppoſition of the Earth being of different Denſities; as Sir *Iſaac Newton* has formed his Calculation on a contrary Principle, that is, of the Earth being of a * uniform Denſity, the Conſequence of which would be, the Power of Gravitation would be in Lines, at right Angles, or perpendicular to the Surface; by which ſuch a Fluid as the Sea would be at reſt, except diſturbed by ſome external

* The ingenious Mr. *Simpſon* has ſhewn, from Mathematical Principles, that if a Planet is of a *uniform Denſity*, and if the Difference between the Polar and Equatorial Diameters are ever ſo great, by the Velocity of its Motion round its Axis, the Power of Gravitation or Attraction will be in Lines perpendicular to the Surface.

Power, as Winds or the Moon, *&c.* But as the Current of the Gulph-ſtream, and ſome others, have a continual Motion, which appears to diſagree with the Suppoſition of a uniform Denſity of this Earth, it may be better, before the Mind aſſents to any Hypotheſis, firſt to conſider what Phenomena a ſuppoſed Circulation of the Sea would produce, then to enquire if there are ſuch that make an Appearance in Nature; and at laſt, to form our Judgment only on ſuch Principles, as are conſiſtent with Phenomena.

Then admitting we were to apply ourſelves to ſuch a Conſideration, upon a Suppoſition of what might be expected from ſuch Caverns of Communication, and favourable different Denſities in this Earth, it would appear,

1ſt, That if the Sea had a Circulation, and the Mouths of any ſuch Caverns as was neareſt the Poles, ſhould not be in deep Water, the Sea-water would deſcend in a Whirlpool. For it is very well known, when Fluids deſcend thro' Pipes of Conduct, that if the Surface of ſuch Fluid falls near ſuch Pipe, it generates into a ſmall Whirlpool.

2dly, It is very likely, the Sea-water might be obſerved to riſe within the Torrid Zone, or in Places near it.

3dly, If there ſhould be ſuch Caverns of Communication, and they ſhould afford Vegetation, it is poſſible that great Quantities of ſuch Vegetables would be ſeen within and near the Torrid Zone, at great Diſtances from Land, as they might be brought up to the Surface by the Currents and Springs of Circulation.

4thly, If ſuch Circulation ſhould have taken Place, it may not be unreaſonable to imagine, that there may be Currents within the Torrid Zone, obſerved to gravitate towards the Temperate Zones.

5thly,

5thly, It might further be expected, that thoſe Currents might be obſerved to continue their forementioned Courſes, in ſome Parts of the Temperate Zones towards the Poles.

6thly, There being known to be many Springs ſtrongly impregnated with Foſſils, Minerals, *&c.* which is undoubtedly by the Water circulating thro' Strata of thoſe Sorts of Matter which they have incorporated; conſequently then, if the Sea has ſuch a ſuppoſed Circulation, it is not improbable, but after a ſubterranean Paſſage of ſuch a great Length, but thoſe Parts of the Sea which are within, or near the Torrid Zone, would be more ſtrongly impregnated with Foſſils, Minerals, *&c.* than Places near the Poles, which are further from thoſe Springs of Circulation.

7thly, As Air is rarified by Heat, and condenſed by Cold, and Land being known to reflect Solar Heat powerfully, while Water abſorbs it, which muſt rarify the Air over the Land conſiderably, while over the Sea it might be expected to be greatly condenſed; then if there are Springs of Circulation that condenſe the Air over the Sea within the Torrid Zone, the Sea Breezes muſt fall more powerfully on the Land in Places within the Torrid Zone, than on Places which are at ſome Times equally hot, within the Temperate Zones.

8thly, If there were ſuch ſuppoſed Caverns, 'tis probable that Places on the Sea-coaſts within the Temperate Zones, might be found hotter at ſome Part of the Year, than Places within the Torrid Zone, although the Solar Rays might have a more oblique Deſcent at that Time on the former than on the latter; as cooling Springs might be reaſonably ſuppoſed to greatly aſſuage the ſcorching Heat of the Torrid Zone.

ably, The difficulties which ſome find who live on the Sea-coaſts, or on the Banks of great Rivers, to confine Water to deſired Bounds, or particular Channels, might induce us to think, that if ſo immenſe a Body of Water as the Ocean was to have a Circulation, the ſubterranean ſubmarine Currents in ſuch ſuppoſed Caverns, would have a powerful Influence over ſuch terreſtrial Matter as had not the ſtrongeſt Coheſion. And if there ſhould be a Quantity of ſuch, whoſe Coheſion was not ſufficiently ſtrong to reſiſt ſuch ſuppoſed Currents of Circulation, and indued with a magnetic Property, 'tis probable ſuch internal Magnets might be obſerved by a dipping Needle to approach nearer the Equator.

Therefore, in order to diſcover if there are ſuch Phenomenon in Nature, as hath been here thought ſufficient to conclude that there are ſubterranean ſubmarine Caverns of Communication, from Places in high Latitudes to Places nearer the Equator; and the Sea circulating thro' them, I muſt beg the Reader's attention to the following Accounts and Obſervations; likewiſe to ſome Queries on ſome of them.

The firſt Appearance of Nature which favours the Hypotheſis of a Circulation, which I ſhall beg Leave to mention, is Whirlpools.

" * In *Frobiſher*'s Streights, after the making of " Mount *Warwick*, there lyes a Whirlpool, where " Ships are whirled about in a Moment, the " Water making a Noiſe a great Way off.

" † *Maleſtrand*, by the *Dutch* called *Maleſtroom*, " a Whirlpool on the Coaſt of *Lapland*, which, " from half Ebb to half Flood, maketh a moſt

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* *Engliſh* Pilot, 4th Book, Part I.

† *Bohun*'s Geographical Dictionary, under the Letters *M. A I.*

" terrible

" terrible Noiſe, which is heard at the Iſlands of " *Roſt* and *Lofoot*, ten Miles off. If any Whale " is taken in by the Current, it makes a moſt " pitiful Outcry; and Trees, when they fall into " it, are torn like Flax or Hemp.

" * South Weſt of *Swinna* (one of the *Orcades*) " are two dreadful Whirlpools in the Sea, com- " monly termed the Wells of *Swinna*, with another " between *Yla* and *Jura* (two of the Weſtern " Iſlands) during the firſt three Hours of Flood, " all of them are very terrible to Paſſengers, and " probably occaſioned by ſome ſubterranean *Hiatus*.

" † Near *Sunderæ*, one of the *Feræ* Iſlands, is " another Whirlpool, of about a Mile over; it is " near *Sumbo* Rock."

Now I muſt beg Leave to obſerve, although the Whirlpool called *Maleſtrand*, makes a Noiſe but from half Ebb to half Flood, that is, while the Tide is low, I have no Manner of Doubt, but the Water deſcends as faſt at high Water when it is ſmooth, as at low when there is a Whirlpool: For if it may be permitted to judge of great Things, by the Obſervation of ſmall, ſomething like it will appear in filling a large Caſk with any Liquid, that is, when the Funnel is full up to the Top, and conſequently the greater Preſſure of Water upon the Pipe of Conduct (which guides the Fluid into the Caſk) there is nearly a ſmooth Surface; but when the Surface ſubſides near the Bottom of the Funnel, it generates into a Whirlpool.

Or if theſe Whirlpools ſhould be conſidered in a natural Way, it is not to be queſtioned, but it would appear as impoſſible for theſe Whirlpools to

* *Gordon*'s Geographical Grammar, p. 198.

† Compleat Syſtem of Geography, Fol. Vol. I. p 926. the Biſhop of *Bergen* gives an Account of three Whirlpools near the *Feræ* Iſlands, in his Natural Hiſtory of *Norway*.

be

be kept in Motion, without large Quantities of Water deſcending towards the Earth's Centre, as it would be for the liquid Water of a Cataract to keep a Station on the Side of a Precipice.

I don't imagine any one can think the Water which deſcends at thoſe Whirlpools undergoes Annihilation after its Deſcent, conſequently then, we may reaſonably ſuppoſe, it muſt riſe ſomewhere.

And as the Force of Gravity at thoſe Parts of the Sea where thoſe Whirlpools are obſerved, is ſuperior to the Power of Gravity, in Places nearer the Equator; alſo as thoſe Whirlpools appear to contradict the Suppoſition of a uniform Denſity of this Earth; Quere, if it is not probable this Water may ariſe in Places within or near the Torrid Zone.

Thoſe Whirlpools perhaps may be thought inſufficient for carrying off ſo large a Quantity of Water, as would be requiſite to make any ſenſible Difference in the Saltneſs of the Sea, or to aſſuage the ſcorching Heat of the Torrid Zone, or to make a Northern In-draught, or a Gulph-ſtream. But I muſt beg Leave to obſerve, that thoſe centripetal Currents, would not have made Whirlpools, at the Surface of the Sea, if they had not been in Places where there was not a great Depth of Water; therefore there may be Numbers of ſubterraneous ſubmarine Caverns of Communication in deep Water, that may carry on a Circulation ſufficient to impregnate the Water of the whole Ocean, with Foſſils, Minerals, *&c.* to aſſuage the ſcorching Heat of the Torrid Zone, and to cauſe all thoſe Currents which have been obſerved at Sea, without diſturbing the Surface of the Sea, over the Parts where the Water enters, that might enable us to diſcover where the Mouths of ſuch Caverns of Communication are.

The

Fig. 1.

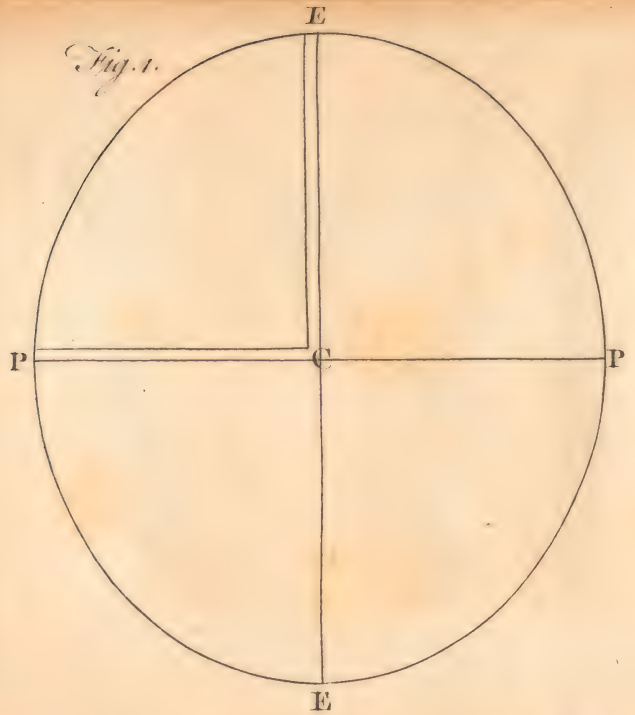
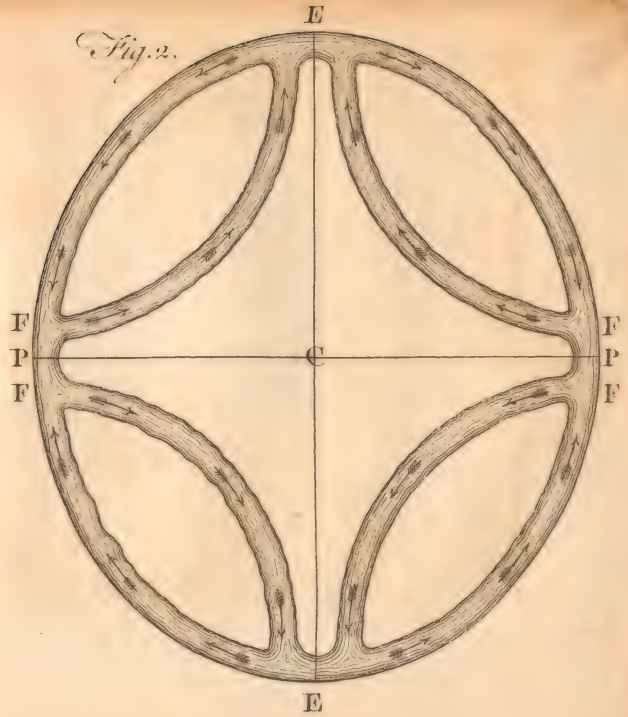


Fig. 2.



The ſecond Appearance of Nature, which favours the Hypotheſis of the Sea's having a Circulation, is, the riſing of the Water of the Sea from below to the Surface in ſeveral Places within and near the Torrid Zone.

Although Things which preſent themſelves commonly to our View, frequently make little or no Impreſſion on the Mind, yet Water of the Sea riſing from below to the Top, and ſpreading a ſmooth Surface of a conſiderable Breadth with a rippling round the Verge in fair Weather, in ſeveral Places within and near the Torrid Zone, I think, cannot have eſcaped any Perſon's Notice, that have been at any of our Iſlands in the *Weſt Indies:* This riſing of the lower Water to the Surface is alſo very diſcernible by the Sea Vegetable, known to Seamen by the Name of Gulph Weed, riſing with it with a much greater Velocity, than it could riſe through ſtill Water, by the ſmall Difference which is between the ſpecifick Gravity of that Vegetable, and the Fluid which it ſwims in. Likewiſe Experience tells us, there is not any Tide, or collateral Current, ſufficient to produce ſuch an Effect: Neither is any ſuch riſing of the lower Water to the Surface obſerved in theſe Latitudes, at ſuch Diſtances from Land and Soundings, as where that is ſeen in and near the Torrid Zone.

The third Appearance of Nature that favours the Hypotheſis of the Circulation of the Sea, is the large Quantities of the Sea Vegetable, known by the Name of Gulph Weed *, which is in ſeveral

* As I proceeded with great Caution, before I attempted to publiſh this Eſſay, by enquiring into the Opinion of ſome, whoſe Judgment and Veracity could be relied on, was inform'd, there was an Author that gave an Account of a particular Weed, which

ral Parts of the Sea within and near the Torrid Zone.

If the Manner of Growth of Sea Vegetables ſhould be obſerved, it would be found that the Generality of them were rooted to Rocks, *&c.* or other hard Subſtances, ſuch as it could ſcarcely be imagined they could draw any Nutriment from; and that ſome Species of them grew to be very large, in Places where there were very ſtrong Tides; or if the Colour of thoſe of the ſame Species that grow in deep Water, and thoſe that grow near the Surface, ſhould be compared, it would be found, that the former had much the lighter Complexion; and I don't know but the ſame Rule governs Terreſtrial Vegetables; that is, that thoſe which are moſt expoſed to the open air, are of the darkeſt Hue; by the lively yellow Colour of Gulph Weed it appears to grow in very deep Water; or if the Quantity of it ſhould be obſerved, which ſeems like ſcattered over a great Part of the Sea, from about one hundred Leagues South Weſt of the Weſtern Iſlands, to over a great Part of the Torrid Zone; and I cannot ſay how far it may be to the Southward, as I never was in South Latitude: I ſay, if this Gulph Weed was not brought up to the Surface of the Sea, from its Place of Vegetation, by Springs of Circulation, How would it be poſſible for ſo many Pieces to be ſeen, which appear to be broke from other Parts by ſome Violence? Or how can we account for the large Quantity thereof,

which grew in great Abundance in the *Caſpian* Sea, and although there was no ſuch Weed known to grow in the *Perſian* Gulph, it was found in the latter Place in great Abundance; but as there was none that appeared freſh, it was conjectured it was brought from the *Caſpian* Sea, thro' ſome ſubterranean Cavern of Communication, as there is no viſible Paſſage between that Sea and Gulph, but the Name of the Author or Book could not be recollected.

when

when in ſailing ſeveral hundred Leagues we are never out of Sight of it? Whereas in theſe Latitudes, if one hundred Leagues from Land, and Soundings, we may ſail fifty Leagues without ſeeing any Sort of Sea Vegetable whatſoever.

The fourth Appearance of Nature that favours the Hypotheſis of a Circulation, is Currents in ſeveral Places near the Continent of *America*, and the Iſlands within and near the Torrid Zone.

* " Upon the Full and Change, the Currents " ſets ſo ſtrong to the Northward, between the " *Leeward Iſlands* and *Jamaica*, that the Allowance " of Five *per Cent.* is but ſufficient, which is five " Leagues in a hundred." Alſo Experience tells me, there is as ſtrong a Current ſetting to the Eaſtward of *Barbadoes* as where that Author mentions.

" From the *Grand Camaines*, it is uſual for Ships " to direct their Courſe for the Iſland of *Pines*, " endeavouring to ſail ſomething to the Weſtward, " in doing of which, be ſure to hawl Weſterly e- " nough, at leaſt a Point of the Compaſs more " Weſterly than the Draughts lay it down, by " reaſon of the Current that ſets ſtrong to the " Northward out of the Bay of *Honduras*, which " if you ſhould not take Notice of, will ſet you " upon the *Jourdans*, which are very dangerous " Shoals and Rocks.

" From *Vera Cruz*, which is in the Latitude of " 19° 30′ N. the Current ſets Northerly as high " as 27° of Latitude along the Shore, and then " it rounds the Bay to the Eaſtward."

Likewiſe I muſt beg Leave to obſerve, that the Current ſets to Windward ſo often off the Iſland

* *Engliſh* Pilot, Book, IV. p. 47. *N. B.* if this was totally the Effect of the Moon's Influence, there would be a Southern Current adequate to the Northern.

of *Jamaica*, that it is common for Ships which are near ready to ſail, to inquire of the Coaſting Sloops and Pilot Boats, which come into Harbour, to inform them how they found the Current ſet out at Sea. Alſo thoſe that ſail from *Jamaica*, thro' the Gulph of *Florida*, find a windward Current, from the Time they get between the Capes of St. *Antonio*, and *Catoche*, till they reach the Gulph of *Florida*. Likewiſe at Sea, near the Continent on the Coaſt of *Caraccas*, not far from *Cartegena*, the Current ſets ſo conſtantly to Windward, that it is the Practice for Ships, which are bound over for any of the Iſlands, or the Windward Paſſage, to ply up along that Coaſt, till they judge themſelves ſufficiently to Windward, to fetch their deſired Port, *&c.* on a Stretch. But as Sir *Iſaac Newton* has laid it down as a Rule, *that to the ſame natural Effects, we muſt as far as poſſible aſſign the ſame Cauſes.* For the better diſcovering what Currents are the Effect of Winds, or what may proceed from other Cauſes, I ſhall take the Liberty of mentioning ſome Obſervations, that have been made on Currents in the *Baltick* Sea and Sound.

Thoſe who have frequented the *Baltick* Sea know, that let the Wind blow ever ſo long Weſterly, there will be a ſtrong Current ſet thro' the Sound, *&c.* into the *Baltick*; or if the Wind blows ever ſo long Eaſterly, the Current will continue to ſet out ſo ſtrong that Ships can ſeldom work to Windward againſt them although they have moderate Gales: The Current ſetting in, never raiſing the Sea of the *Baltick* after the firſt two or three Days; and the Current ſetting out with an Eaſterly Wind, never making it fall after the like Time, occaſion'd ſome Speculation, till * Dr. *Smith* was informed

* Philoſ. Tranſ. N. 158. p. 564.

by

by a Seaman that tried the Current, and found, there was as ſtrong an under Current, as there was an upper Current, and that they had each a Motion counter to each other; which kept the Sea of the *Baltick* nearly at an Equilibrium with the Weſtern Ocean: And as I now think theſe Obſervations on Currents ſufficient for my preſent Purpoſe, I ſhall next proceed to make ſome Remarks thereon, and humbly ſubmit their following Queries.

Remark the firſt. As there is a Northern Current ſets between the *Leeward Iſlands* and *Jamaica*; and as the Continent ſtretches along to the Southward and Eaſtward to Cape *St. Roque*, which is about 890 Leagues S. E. ¼ E. from the Eaſt End of *Jamaica*, there being likewiſe a Southern Current, to the Southward of Cape *St. Roque* (which ſhews it cannot come from the Southward) and the Trade Winds, between the *Leeward Iſlands* and *Jamaica*, being from about N. E. to E. which is partly againſt the Current.

Queræ, then can this Northern Current be ſupplied, except by Springs of Circulation, at the Full and Change; and if it is not an under Current when the Moon is in the Quadrature, but gravitates more ſtrongly towards the Moon, when it has the moſt powerful Attraction.

Remark the Second. As there is a Windward Current from between the Capes *Catoche*, and St. *Antonio*, to the Gulph of *Florida*, and a Current from *La Vera Cruz*, in the Bay of *Mexico*, which ſets to the Northward as high as 27° of Latitude, and then * rounds the Bay to the Eaſtward: Now

* From the Bay *Apalachio* to the In-draught of the Gulph-ſtream, Experience likewiſe informs me there is an Eaſtern Current.

La Vera Cruz being above 200 Leagues about W. by N. from Cape *Catoche*.

Queræ, if the Current from *La Vera Cruz*, which rounds the Bay of *Mexico* to the Northward, and Eaſtward, is not a Current ſupplied from Springs of Circulation; or if there is the leaſt Probability of its coming into that Bay, between the Capes *Catoche*, and St. *Antonio*.

Remark the third. As there is continually a Northern Current ſets between the Capes *Catoche*, and St. *Antonio*, and a very ſtrong Current perpetually, thro' the Gulph of *Florida*; alſo, an Eaſterly Current generally on the Coaſt of *Caraccas*, and the like ſometimes off *Jamaica*, which Currents are ſome in a direct, and others in an oblique Direction, againſt the trade Winds; and as the Currents in the *Baltick* Sound, *&c.* are altogether govern'd by the Winds, and have under Currents, which keep the Seas in Equilibrinm; likewiſe the Winds in theſe Parts have a powerful influence on our Tides.

Queræ, then, if the fore-mentioned Currents can have a ſupply of Water, or if the Water, thus in Motion, can receive any Impulſe from any Power whatſoever, ſufficient to force them againſt the Force of Winds, except by Springs of Circulation.

The fifth Appearance of Nature, that favours the Hypotheſis of a Circulation of the Sea, is Currents inclining towards the Poles, within the Temperate Zones.

"The Rev. Mr. *Walter* ſays * we found a "conſiderable Current ſetting to the Southward, "after we had paſſed the Latitude of 16° South; "and the ſame took Place all along the Coaſt of *Brazil*, and even to the Southward of the River of

* Lord *Anſon*'s Voyage, p. 53.

Plate,

Plate, it amounting sometimes to above thirty Miles in twenty-four Hours, and once to above forty. * Also near a-breast with Cape *Virgin Mary* he concluded they had a Current, which set them twelve Miles to the Southward.

Likewise, if we proceed to Observations in this Northern Temperate Zone, those who sail to *South Carolina* can inform us, that they meet the N. E. Current from the Gulph of *Florida*, before they reach Soundings; and that this Current is sometimes discovered as far North as the Capes of *Virginia*.

† Sir *George Mackenzie* gives an Account of several Nuts, such as are called Cohoon Nuts in *Jamaica*, and of a Cabbage-tree being drove Ashore at the *Lewis* Islands, to the Westward of *Scotland*.

" § Likewise all the Wood, which is thrown " on the Coasts of *Greenland*, *Nova Zembla*, *Lap-* " *land*, and other Northern Countries, is Worm- " eaten; which is a Proof this Wood comes from " warmer Climates; since it is certain, Ships are " not Worm-eaten in that Northern Sea." Now, as the N. E. Trade Wind commences to the Northward of those Places, which are most noted for the Growth of Cabbage-trees, or Cohoon Nuts; and by ‖ Captain *Middleton's* Observations it appearing, " That in *New England*, the Wind blows from

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* Lord *Anson*'s Voyage. p. 103.

† *Lowthorp*'s Abridgment, Philos. Trans. Vol. II. p. 785.

§ Compleat System of Geography, Fol. Vol. II. p. 785.

‖ *Martyn*'s Abridgement, Philos. Trans. Vol. IX. p. 47.

I have been informed by a Commander in the Navy, that it is reported that the Heel of the Topmast of his Majesty's Ship the *Tilbury* (which was burned between the Islands of *Jamaica* and *Hispaniola*) was ~~taken up at Sea to the Westward of Scotland~~ drove ashore ~~Lewis~~ that a Part of it was burnt, and the Ship's Name *Tilbury* was on the Part they took up. x

x Capt^n Gordon informed me that the
this is a fact, since the above
was printed here also been told that
Adm^l Rodney had the Command of a Ship
at Shetland, when the Topmast was drove
ashore on those Islands

" the North near four Months in the Winter, at " *Canada*, about 5 Months, at *Danes Settlement*, " *Straight Davies* in the Latitude of 63° N. near " seven Months; and on the Coaſt of *Norway*, " in the Latitude of 64° N. above 5 ½ Months.

Queræ, then if thoſe Winds are not ſufficient to keep Timber, *&c.* from being brought from warmer Climates, if the Sea was a Fluid which had no Motion, but by the Impulſe of Winds, and that known by the Name of Tides; or if there is a Probability of their being brought ſo far to the Northward, except by Currents from Springs of Circulation.

The ſixth Appearance of Nature, which favours the Hypotheſis of the Sea having a Circulation, is, the Difference in the Saltneſs of ſeveral Parts of the Ocean.

" * Mr. *Boyle* having recommended to a learned " Phyſician who was ſailing into *America*, and " furniſhed him with a ſmall Hydroſtatical In- " ſtrument, to obſerve, from Time to Time, the " Difference of Gravity he might meet with; " this Account was returned him, that he found " by the Glaſs, the Sea Water to increaſe in " Weight the nearer he came to the Line, till he " arrived at a certain Degree of Latitude, as he " remembers, about the Thirtieth; after which the " Water ſeemed to retain the ſame ſpecifick Gra- " vity, till he came to *Barbadoes* or *Jamaica*.

" † Dr. *Stubbs* ſays, I obſerved at Sea, after " we were out of the Narrow, the Sea grew " darkiſh, and after a perfect Azure; yet was it " much more Salt the farther we went, as I tried " by a Water Poiſe, which aroſe about half an

* *Lowthorp*'s Abridgment Philoſ. Tranſ. vol. II. p. 297.
† *Lowthorp*'s Abridg. of the Philoſ. Tranſ. vol. 3. p. 547.

" Inch

" Inch above the Sea Water, in the *Downs*, and " at twenty-four Degrees more, two Inches; but " after that I never obſerved any Difference unto " *Jamaica*; the Sea being probably ſo ſtrongly " impregnated with Salt, as not to imbibe any " more."

If the Water, from ſaline or mineral Springs, ſhould be examined at different Diſtances from Springs, I don't know there is the leaſt Reaſon to doubt, but that they would be found weaker and weaker, the further they had gravitated from the Springs, by the more heavy Particles ſubſiding, and by freſh Water mixing therewith. Pray then, when the fore-mentioned Appearances of Nature are conſidered, is not the greater Saltneſs of the Sea, within the Torrid Zone, and the gradual Decreaſe thereof, towards the Poles, a ſtrong Indication of the Sea having a Circulation.

The ſeventh Appearance of Nature, which countenances the Hypotheſis of the Sea having a Circulation, is, ſtrong Sea Breezes falling conſtantly upon the Land within the Torrid Zone, when the Solar Heat is powerful, and little or not nigh ſo ſtrong at ſome Places within the Temperate Zone, particularly at *South Carolina*.

* Mr. *Boyle* has ſhewn, by ſeveral Experiments, that Air is rarified by Heat and condenſed by Cold; from whence he alledges, that the ſtrongeſt Cold in *England* doth not contract the Air more than $\frac{1}{12}$th Part.

† Mr. *Robins* concludes from ſome Experiments which he made, that Air is expanded by the Flame of fired Gun Powder, in the Ratio of 194$\frac{1}{2}$ to 796.

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* *Lowthorp*'s Abridgment, vol. II. p. 9.

† New Principles of Gunnery, by *B. Robin's*, F. R. S.

" * Sir *William Beeſton* obſerved his Barometer " in *Jamaica* diligently every Day; and found in " the Morning before the Sun aroſe, the Mercu- " ry ſtood one Degree below changeable; and as " the Heat increaſed, it ſunk within one Degree " of above Rain."

It is generally acknowledged by thoſe, who have reſided ſome Time at *Jamaica*, and *South Carolina*, that the Heat of the latter exceeds any Heat of the former Place, about three Months in the Summer.

† Dr. *Lining*, in a Letter from *South Carolina*, ſays, " in Summer the Heat of the ſhaded Air about " two or three in the Afternoon, is frequently be- " tween 90 and 95 Degrees of *Fahrenheit*'s Mercu- " rial Thermometer; on the 14th, 15th, and 16th " of *June*, 1738, at 3 *PM*, it was at 98, a heat " equal to the greateſt Heat of the human Body.

Now, as it is a Property of Air, as has been obſerved, to be rarified by Heat, the Air of *South Carolina* muſt be thinner in a Summer's Day than the Air of *Jamaica*, admitting the Mercury in the Barometer at equal Height at both Places; but by the Air at *Jamaica* gravitating very powerfully from the Sea upon the Land, in the Heat of the Day, from ſtatical Principles, the Air of the Sea muſt be a great deal more condenſed within the Torrid Zone, than near *South Carolina*, where they have not a regular Sea Breeze. Now, as it is likewiſe a Property of Air to be condenſed by Cold, as has been obſerved. Queræ, How can the Air over the Sea within the Torrid Zone be more condenſed, than the Air over the Sea in the Latitude of *South Carolina*, except by cooling Springs of Circulation riſing within the Torrid Zone.

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* *Lowthorp*'s Abridg. Philoſ. Tranſ. vol. II. p. 9.
† Philoſ. Tranſ. N° 487, Letter 12.

The

The 8th Appearance of Nature, which favours the Hypotheſis of the Sea's having a Circulation, is the Coolneſs of the Torrid Zone; the greater Heat of ſome Places within the Temperate Zones, and the Difference of Heat of ſeveral Places in the ſame, and equal Latitudes.

Mr. *Boyle* relates an Experiment he made in the following Manner.

" * We took ſome hard, black Pitch, and hav-
" ing, in a Baſon, Porringer, or ſome ſuch Veſſel,
" placed it a convenient Diſtance under Water,
" we caſt on it, with a good Burning glaſs, the
" Sun Beams, in ſuch a Manner, that notwith-
" ſtanding the Refraction that they ſuffered in their
" Paſſage thro' the interpoſed Water, the Focus
" fell upon the Pitch; wherein it would produce
" ſometimes Bubbles, ſometimes Smoak, and
" quickly communicated a Degree of Heat, ca-
" pable to make Pitch melt, if not to boil."

† Captain *Henry Ellis*, F. R. S. in a Letter to the Reverend Dr. *Hales*, F. R. S. after mentioning ſome Advantages received from Dr. *Hales*'s Ventilators, ſays, " Upon the Paſſage I made ſeveral
" Trials with the Bucket Sea-gage, in the Lati-
" tude 25° 13′ N. Longitude 25° 12′ W. I
" charged it, and let it down to different Depths,
" from 360 Feet to 5346 Feet, when I diſcovered,
" by a ſmall Thermometer of *Farenheit*'s, made by
" Mr. *Bird*, which went down with it, that
" the Cold increaſed regularly, in Proportion
" to the Depths, 'till it deſcended to 3900 Feet;
" from where the Mercury in the Thermometer
" came up at 53 Degrees; and tho' I afterwards
" ſunk it, to the Depth of 5346 Feet, that is, a

* *Boyle* on the Mechanical Origin of Heat and Cold; *Experiment the Third.*

† Philoſophical Tranſactions, Vol. 47.

" Mile and 66 Feet, it came up no lower. The " Warmth of the Water upon the Surface, and " that of the Air, was at that Time, by the Ther- " mometer, 84 Degrees: I doubt not, but the " Water was a Degree or two colder, when it en- " tered the Bucket, at the greateſt Depth, but in " coming had acquired ſome Warmth of the " Water upon the Surface; for I found, that the " Water which came up in the Bucket, having " ſtood 43 Minutes in the Air, the Time of " winding it up, the Mercury roſe above five De- " grees. — When the Air had rendered it equally " warm with the Water on the Surface, I tried " their Weight, by weighing equal Quantities " very exactly, as alſo by the Hydrometer; and " found, from the greateſt Depths the heavieſt, " and conſequently the ſalteſt Water, *&c.*"

If the Accuracy and Care, with which Captain *Ellis* made this Experiment, is obſerved, and that the Mercury roſe five Degrees, in an equal Time to that which the Bucket was winding up, I don't apprehend there can be any Difference in Opinion, as to the Water being a Degree or two colder, when it entered the Bucket, at the greateſt Depth.

By this Experiment (for which we are obliged to the Reverend Dr. *Hales* and Captain *Ellis*) it appears, the ſolar Heat penetrates into the Sea to above the Depth of a Mile: and as the Sea is known to gravitate to the northward, in North Latitude, and to the Southward, in South Latitude, which has been obſerved when Currents were ſpoken of; I don't queſtion but the acquired Heat, which the Sea had imbibed in its Paſſage to the Latitude of * 28° S. (and the Latitude of 32° 40′ N.

* The Reverend Mr. *Walter* obſerves, " That the Mercury " in a Thermometer of *Fahrenheit*'s was but once up at 76 De- " grees in the whole Voyage, and that was at St. *Catherine*'s." *Lord* Anſon's *Voyages*, p. 254.

the

the latter being nearly the Latitude of *South Carolina)* may more than compenſate for the oblique Deſcent of the ſolar Rays, and cauſe that greater Summers Heat, than of the Torrid Zone.

Now if it be admitted, that the Sea, in the Latitude of 28° S. or 32° 40′ N. is the moſt ſtrongly impregnated with the ſolar Heat, which, I think, the ſuperior Heat of St. *Catherine*'s and *South Carolina* ſeems to indicate; it is very certain a Body of Water, ſeveral hundred Leagues over, heated to above a Mile deep, will retain the Heat a conſiderable Time, and will have a warm Influence on the Coaſts, which are adjacent to it in its Paſſage to high Latitudes; which way of Reaſoning, the Current on the Coaſt of *Braſil* ſeems to countenance, as there is always a Paſſage free from Ice round *Cape Horn*; which is nearly in the Latitude of 57° 50′ S. although Dr. *Halley* found the Icy Sea to commence in the Latitude of 52° S. at a great Diſtance to the eaſtward of that Coaſt. Nor is it the high Latitude of *South America* alone that enjoys that Bleſſing, we having a northern Indraught, as has been obſerved, on theſe Coaſts: Therefore if the Heat of ſeveral Places in the ſame or equal Latitudes ſhould be obſerved, it would be found, that the Latitude of a Place was not a certain Criterion, for to inform us of the Heat or Coldneſs thereof; but that neighbouring Countries and Seas participate of the Heat or Cold of each other. For, as the Reverend Mr. *Walter* has obſerved, the Pacifick Ocean, within the Torrid Zone, on the Coaſt of *Peru*, partakes of the Coolneſs of the frozen Summits of the *Andes*. — Now if we obſerve *Ireland* (which is not improbably warmer in the Winter than any other Iſland in the World, when its Largeneſs and Diſtance from the Equator are admitted) partakes of the Heat which is con-

veyed with the Sea from the Torrid Zone. Thoſe Parts of *England*, which are in the ſame Latitude of Part of *Ireland*, being farther diſtant from the weſtern Ocean, and conſequently do not partake ſo much of its warm Influence, have the Winters cooler than thoſe of *Ireland*: Likewiſe if we proceed to thoſe Places on the Continent, which are ſtill more remote from the weſtern Ocean (and conſequently from the warm Effects thereof) the Winter will be found colder than either of the former. But if we ſhould proceed to Obſervations in *Hudſon's Bay*, it would be found colder than any Part of the Continent of *Europe* in the ſame Latitude, although thoſe Parts of *Hudſon's Bay* may be nearer the Sea; yet when it is conſidered, that the weſtern Springs of Circulation, which appear by Currents to be in the Bay of *Mexico*, gravitate from the Gulph of *Florida* in a North Eaſt Courſe for a conſiderable Way; and as there has not been any northern Ice-draught diſcovered on the Banks of *Newfoundland* by thoſe that have * fiſhed there, it appears to take a more eaſterly Courſe, which muſt carry it a great Diſtance from *Hudſon's Bay*; whereas by the Clearneſs of our northern *European* Sea from Ice, and the worm-eaten Timber, which is brought to thoſe northern Countries, the Sea appears to circulate a great way round the Northern Parts of *Europe*, which may probably make that

* I wrote down to a Merchant at *Briſtol* to enquire of ſome of the Maſters of Merchantmen that uſed *Newfoundland*, concerning the Currents on the Banks; and had for Anſwer, That they had Currents which ſet, at different Times, ſeveral Ways; but, in the general, had no particular Tendency.—This Obſervation on Currents having an Eaſtern Courſe, is likewiſe countenanced by Ships often falling in with Cape *Finiſtre*, in ſailing to the South, when by reckoning they might have expected to have been conſiderably to the Weſtward of that Cape.

Difference

Difference that is between the Winter's Cold of Places in *America* and *Europe*, which are ſituated in the ſame Latitude.

But if a Theory of the Summer's Heat of theſe forementioned Places ſhould be attempted, the Sea abſorbing the Solar Heat to a great Depth, the Atmoſphere over it will be much cooler than that of the Land, which will reflect the Solar Heat: Therefore *Ireland*, by its Vicinity to the Weſtern Ocean, will have cool Summers; and *England*, which is farther diſtant, will have its Summers warmer; and thoſe Places in the ſame Latitude on the Continent muſt be warmer than either of the former, as the reflected Solar Heat from the Land cannot be ſo much aſſuaged by Currents of Air from the Sea, by reaſon of the latter's more remote Diſtance. And as to thoſe Places in *Hudſon's Bay* which are contiguous to the Sea, it is not improbable but that they may have their Summers cooler than any of the former; for as thoſe Parts of the Sea have not any Supply of Warmth from the Torrid Zone, 'tis probable it will have a cooler Influence on the Air on the Shore than the Sea near theſe Kingdoms; for although ſome may probably imagine, by the Heat of th s Part of the Weſtern Ocean, which is near theſe Coaſts, that Heat is an inſeparable Property of Sea Water. — But if thoſe that may be of that Way of thinking would give themſelves Time to conſider, that there is an Icey Sea, which commences in the Latitude of 52° South, at a great Diſtance from any known Land, 'tis probable, that would be ſufficient to make them be of another Opinion. — Some others may poſſibly think, that as Sea Water will not congeal with the ſame Degree of Cold, as freſh Water will, that its retaining the Liquid State longer, is an

Indication

Indication of its greater Heat; but that cannot be admitted as a Reaſon, for Mercury, which is as ſuſceptible of Cold as any Fluid whatſoever, is never congealed; therefore, that great Retenſion of a liquid State, which is obſerved in Sea Water, may proceed from ſome other Cauſe than Heat; which may not improbably be, by having ſmaller or fewer Pores than freſh Water, or being impregnated with Sulphur, *&c.* not that it may be unreaſonable to imagine, that that Part of the Sea which is ſalteſt may be warmeſt, in high Latitudes, by having a quicker Circulation.

If there ſhould be an Attempt made to eſtimate the Advantages this Earth appears to receive from a Circulation of the Sea, ſome might probably think, that the Winter of *Shetland*, which is in about the Latitude of 60° 10′ N. being warmer than *Cape Breton*, which is in about the Latitude of 46° 30′ N. is as great an Advantage as might be expected; but if the Summer's Heat of *Charles Town*, *South Carolina*, is made the Standard to judge by, as to the Heat that might be expected within the Torrid Zone; it may be obſerved, the Sun never comes nearer the Zenith of that Place than 9 Degrees. Then that Opinion of the Antients, that the Torrid Zone was uninhabitable, will not appear altogether inconſiſtent; for altho' the frozen Creſts of the *Andes* have a cool Influence on the Parts to the Weſtward thereof. The Trade Winds which may partly be cauſed by the Earth's Motion round its Axis, might prevent any cool Effect therefrom to the Eaſtern Coaſt; conſequently then, I ſay, if we judge by the Summer's Heat of *South Carolina*, all the Eaſtern Coaſt, and other Parts which have not any Benefit from the cool Influence of the Tops of frozen Mountains, would appear to be uninhabitable, except by ſable *Africans*;

Africans; who, probably, have Conſtitutions better adapted to hot Climates, than the other Parts of the Human Species. — Or, if this Calculation ſhould be extended to high Latitudes, it might be proper to obſerve, that there is an Icey Sea in the Latitude of 52° South, but as the Icey Sea doth not ſtretch far Eaſtward, or Weſtward, and as the Sun muſt have a like Influence on all Places of the Sea which are in the ſame or equal Latitudes; it is probable there is a Circulation to the Eaſtward and Weſtward thereof. Then beſide the Advantage this Icey Sea hath from the Solar Heat, it muſt receive a great deal of Heat by Eaſterly and Weſterly Winds, from thoſe warm Currents, which are probably to the Eaſtward and Weſtward thereof; which it is not improbable, but that they may keep the Sea from congealing two or three Degrees nearer the Equator, than it would have done, had there been no Circulation; by which an Icey Sea might be expected to commence in the Latitude of 49 or 50°, which would totally ſtop the Paſſage round *Cape Horn*, or make it extremely difficult. And, as to our Parts in theſe Latitudes, it would conſequently deſtroy all our Northern Navigation, and do much more Damage by rendering ſeveral Parts of the Earth (which at preſent are well inhabited) uninhabitable, for want of a ſufficient Heat to ſupply Vegatation. All which Evils appears to be happily prevented by a wonderful Mechaniſm in Nature; by which the cooler Climates are ſending conſtant Supplies of cool Water thro' Caverns of Foſſils, Minerals, &c. which gives a Saltneſs to the Sea, alſo a Coolneſs and Salubrity to the ſcorching Air of the Torrid Zone; and the Torrid Zone in return, ſends the Sea fully impregnated with Solar Heat, for the cooler Regions.

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The ninth Appearance of Nature which favours the Hypotheſis of a Circulation of the Sea, is, the Motion of Magnets within the Body of the Earth.

If we were to attempt to form a Judgment of what Sort of Matter the internal Part of this Earth was compoſed of, I don't know that it would be Philoſophical to ſuppoſe it was made up of any other Materials, but ſuch Earths, Foſſils, Minerals, *&c. &c.* as Chance, or Induſtry had brought to our View. — Then, as there has been * Magnetical Sand brought, from the *Eaſt-Indies*, *Virginia*, *Italy*, &c. it is not a Thought inconſiſtent with Nature, to imagine that there is large Quantities of it within the Body of the Earth: Or, if we would willingly inform ourſelves, by what natural Power, Earth, Sand, *&c.* had been moved, in nearly a colateral, uniform Motion at any Time, I don't know that we could diſcover any other Agent, ſo powerful as Water; the Power of that Fluid, in moving Terreſtrial Matter, is ſo perſpicuous, that if we believe the Teſtimony of others, or will take the Trouble of inſpecting into Nature ourſelves, it will give us no Reaſon to doubt of its being ſufficient to move thoſe Magnets (which have Motion) within the Body of the Earth.

" † The going into *Cookmore* Haven, the Depth " is uncertain, when it blows a Storm out of the " Sea, the Harbour is barr'd up with Stringle, " and opened again with the Land Floods.

" *New-Haven* is much alike in all Reſpects to " this and is ſubject to the like Inconvenience.

" ‖ The River's Mouth of *Bayonne* lies in be- " twixt two plain Strands E. by N. and W. by S.

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* *Martyn*'s Abridgment, Philoſ. Tranſ. Vol. VIII. p. 739.
† *Engliſh* Pilot, Part I. p. 24. ‖ P. 69.

" and

" and ſometimes more Eaſterly or Northerly, by " reaſon of the ſhifting of the Sand before the Ri- " ver's Mouth."

A Part of the Directions for ſailing into *Port à Port*, ſays, * " On the South Side of the River, " goes in alſo a Land, deep to the Southward of " the aforeſaid ſunken Rock, which lies in the " River's Mouth, where the Pilots ſometimes bring " Ships in and out. That is a good Channel but " ſubject to ſuch ſudden Alterations, as not to be " depended upon."

Some Part of *Yarmouth* Sands have ſuffered ſuch Alterations by the Tides, *&c.* that ſome of the Brethren of the *Trinity-Houſe*, and Mr. *Lounder*, a Draughtſman of his Majeſty's Yard at *Woolwich*, went down there in 1753, and for the Safety of that Navigation, were obliged to make a new Survey. Now, as the Sea is known to be ſo powerful in the forementioned Places, in moving terreſtrial Matter, what may not be effected by Currents of Circulation, when ſome of them appear to make a Stream on the external Part, which is generally allowed to have a Motion of 120 Miles in 24 Hours, as the Gulph Stream; or of 30 or 40 Miles, as on the Coaſt of *Braſil?*

By the Magnet's Motion, being generally taken Notice of to diſcover the Variation, ſome may probably imagine, that the Motion is only Weſterly; but Mr. *Norman* (who was the firſt Inventor of the Dipping-needle) obſerved the Angle of the Dip below the Horizon, in the Year 1576 to be 71° 50′; in 1613 it was obſerved to be between 72 and 73°; in 1676, Mr. *Bond*'s Scheme of the Dipping-needle informs us, it was about 73° 30′; and Mr. *Whiſton* ſays †, in the Year 1721, it was

* *Engliſh* Pilot, Part I. p. 79.

† Mr. *Whiſton*'s Account in his *Latitude and Longitude found out.*

by a Needle of one Foot, not poiſed, 73° 45′; but by one of four Foot, poiſed, above 75°, which was alſo the true Dip of the ſmalleſt Needle. By which Obſervations the Magnet appears to have ſome Southing as well as Weſting in its Motion; by which it muſt reach nearer the great Bay of *Mexico*, where the Springs partly ſupply that wonderful Current the Gulph Stream.

* Dr. *Cheyne*, when deſcribing the Advantages this Earth receives from the Moon, ſays, "She "raiſes our Tides twice in twenty four Hours; "which, how abſolutely neceſſary that is towards "the Subſiſtance of Animals and Vegetables, we "ſhall now ſhew.

"Every Body knows, that a Lake, or Lough, "that has no freſh Water running into it, will, "by the Heat of a few Months, and its Stagna-"tion, turn into a ſtinking, rotten, Puddle; ſend-"ing forth nauſeous and poiſonous Steams: for "though I don't think the conſtituent Particles "of Water are altered by this Stagnation, yet no "Water is abſolutly pure." Now if it be preſumed the Doctor was a Judge of what was ſuſceptible of Putrifaction, it will appear there is a Neceſſity for the Sea to have a Circulation, as there are no Tides within a great Part of the Torrid Zone, that have been thought worthy of Conſideration † in Navigation: whereas, if Tides were to keep the Sea from Stagnation (the greater Solar Heat being within the Torrid Zone) it might not be unreaſonable to imagine, that it required the greater Tides; as the ſame Bodies are

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* Philoſophical Principles of Religion.

† At all our Iſlands in the *Weſt Indies*, and in the Bay of *Honduras*, it doth not flow more than three or four Feet in at Full and Change; and the Moon hath no Influence over the Sea in the Quadratures.

known

known to be more ſuſceptible of Putrifaction in hot Weather than in cold. But as the greateſt and moſt uſeful Diſcoveries have generally met with much Oppoſition, although they have had Men of great Learning and Genius to ſupport them; therefore it would be the greateſt Abſurdity in me to expect, that the World ſhould come into my Way of thinking, except from the Reaſonableneſs thereof; inaſmuch as there can be no ſtronger Preſumption in favour of any Hypotheſis, than its agreeing with the Appearances of Nature: Therefore I ſhall only deſire to know, if we were to conſider the Works of the great Author of Nature, from the moſt glorious celeſtial Bodies to the Comets, then this Planetary Syſtem of Primary and Secondary Planets, the Primary receiving and reflecting the Solar Light to their Attendants, the latter in return doing the like to their Primary Planets; and then the various Ways of Production and Maturation, in animal and vegetable Life, with the Magnificence, Beauty, and Harmony of the whole: I ſay, when theſe are fully conſidered, I ſhall only deſire to know which appears moſt conſiſtent with the Courſe of Nature; that the Ocean, which encompaſſes the greater Part of this Earth, ſhould have no other Mechaniſm than a great Water, put ſometimes in violent Motion by Wind, and ſome Part thereof having another Motion, by gravitating towards the Moon, *&c.* and that the external Part of the Earth, *&c.* was a Shell, containing a great looſe Loadſtone within, as a Nucleus, or Kernel, which would not obey the Laws of Gravitation, but was kept in Motion to imploy Philoſophers to obſerve how it moved, and to give Seamen ſome Trouble to find out the Bearings of its neareſt Pole. —— Or that the ſubmarine Earth hath ſeveral Caverns of Communication,

whoſe Northern Mouths are near *Nova Zembla*, and to the Weſtward and Southward thereof; ſome of which Caverns reach into the Bay of *Mexico*; and others from about one hundred Leagues S. W. of the Weſtern Iſlands, over a great Part of the Torrid Zone. And that there are others in the Southern Hemiſphere, ſome of which have their Southern Mouths to the S. E. of the *Cape of Good Hope*; and others to the Southward of *Terra del Fuego* of *America*, and the like in the *Pacifick* Ocean; all which have a Communication with the Torrid Zone, thro' Foſſils, Minerals, *&c.* and by the Earth being of different Denſities in different Parts thereof, and by the Motion round its Axis, this Water circulating from cooler Climates condenſing the Air, and giving a Coolneſs and Salubrity to it in thoſe Places, where it riſes within the Torrid Zone, likewiſe will be ſtrongly impregnated with thoſe Foſſils, Minerals, *&c.* which it glided on in its Paſſage. And when the Solar Heat becomes powerful on the Shore, the Land, by reflecting that Heat, muſt rarify the Air; while the Solar Heat at Sea will be abſorbed by that Fluid, which will keep the Air over the Sea from being ſo much rarified as that over the Land, and conſequently heavier; which, from Statical Principles, muſt gravitate from the Sea to Land, and make a Sea Breeze. And by the large Quantities of Water, which is continually receding from the Earth's Axis, there will be a Redundancy at the Equator, which will gravitate with a ſlow Motion towards the Mouths of the Caverns which are near the Poles, endeavouring to preſerve an Equilibrium; but having imbibed great Quantities of the Solar Heat, *&c.* the Lands, *&c.* which are contiguous to it, or near it, in its Paſſage into the cooler Climates, will partake of its warm Influence;

fluence; while thoſe Parts which are far diſtant, tho' in the ſame Latitude, may be conſiderably cooler; which may make that Difference of Heat, which is obſerved in Places in the ſame Latitude; and Magnetical Sand, &c. being in ſome one of thoſe Caverns of Communication, may be carried on with a ſlow Motion. So, while the cooler Climates are continually affording a comfortable Coolneſs to the Torrid Zone, the Torrid Zone is continually returning that Favour, by ſending, by the ſame Vehicle, its Redundance of Heat to the cooler Climates: I ſay, I ſhould be glad to know which Theory appears moſt conſiſtent with that Magnificence, Beauty, and Harmony, by which the Univerſe ſeems to be governed.

Indeed, our being brought up in the Opinion of the Sea's being a Fluid in a State of Reſt, except thoſe Motions which are cauſed by Winds and Tides, as has been obſerved; the ſtrong Habits of the Mind to its uſual Way of thinking, may be of ſuch powerful Force as may make it very hard to conceive, that there are ſuch vaſt ſubterraneous ſubmarine Caverns of Communication, from the cooler Regions to the Torrid Zone, for cooling the ſcorching Heat of the latter, and warming the frigid State of the former, and impregnating the Sea with ſuch Foſſils, Minerals, &c. as will give a Salubrity to the Air; but if we give ourſelves the Trouble to inſpect into the wonderful Mechaniſm of Nature, in the Production of an Inſect, or Vegetable, even of a Butterfly, or Miſſletoe, &c. I think it may give no room to doubt, but that there may be ſomething as wonderful in the Mechaniſm of this Planet, that may greatly enable it to produce Subſiſtence, for its great Number of Inhabitants; and that the Structure of the internal Parts, may not be of leſs Service thereto, than ſome Part of the External; and, I think, that

that Coolneſs which has been obſerved in ſome Part of the Torrid Zone, ſeems to be a ſtrong Indication thereof; as well as that Difference in the Heat of Places which are in the ſame Latitude.

But if it ſhould not be admitted that the Sea has a Circulation, and as it appears there is a ſufficient Authority for the Minds aſſenting, to the Exiſtence of Whirlpools; the riſing of Sea-Water, within and near the Torrid Zone; the great Quantities of Gulph-Weed within the Torrid Zone, at great Diſtances from Land; and no Sort of Weeds in the Temperate Zones far from Land; Currents within the Torrid Zone, taking their Courſes towards the Temperate Zones, and Currents in the Temperate Zones continuing their Courſes towards the Frigid Zones: Alſo the Sea-Water within and near the Torrid Zone, where the Sea-Water is obſerved to riſe, being ſalter than Sea-Water in high Latitudes; likewiſe the Sea Breezes being much more powerful within the Torrid Zone, than in Places that are hotter within the Temperate Zones; Places in the Temperate Zones being hotter for three Months together than Places in the Torrid Zone; Places in *Europe* near where a Northern In-draught is obſerved, being much warmer in the Winter, than Places in the ſame Latitude on the Coaſt of *America*; and the internal Magnet of this Part of the Earth having a Southern as well as a Weſtern Motion. I ſay, if any Perſon ſhould be perſuaded that theſe ſeveral Phenomenon are not the Effects of a Circulation of the Sea, I ſhould eſteem it the greateſt Favour, if they would pleaſe to condeſcend to offer any other that is more conſiſtent with the Magnificence, Beauty, and Simplicity of Nature; as the Advantages which may attend a new Diſcovery in Nature, may be of greater Conſequence to Navigation, &c. than might be at firſt imagined.

But

But if we were to admit that the Sea has a Circulation, it only remains to review what Loſſes or Diſappointments have happened in the Practice of Navigation, which might have been occaſioned by it; and what Advantage may be made by knowing and allowing for the circulating thereof.

The Loſſes and Diſappointments by Ships falling into the Northward (when bound for this Channel) have been too conſiderable to eſcape Notice; and the Diſappointments which have happened by Ships miſſing the Iſlands of St. *Helena* and *Barbadoes*, would appear to be by their falling to the Southward of the former, and to the Northward of the latter, being carried by the Streams, from Springs of Circulation gravitating towards the Poles, which if there were ſome Allowance made for them, the Practice of Navigation might be attended with greater Succeſs, more particularly, when the Moon is near the Full or Change, the Currents ſetting ſtrongeſt at thoſe Times.

Whether this ſuppoſed Knowledge of a Circulation may be of any Service in enabling us to know, when we come near to any Continent in high Latitudes, Experiments can only ſhew; it may be obſerved, that the Saltneſs, with which the Ocean is ſo ſtrongly impregnated, ſprings within and near the Torrid Zone; conſequently in its Length of Paſſage to theſe Latitudes, it has a Number of freſh Water Rivers running into it, which never reach to any great Diſtance from Continents, or Soundings. Now as there is a conſiderable Difference between the Specific Gravity of Sea, and freſh Water; and as any Difference of the Saltneſs may be known to nearly a thouſandth Part by the Swimming of a Hydrometer; it is not improbable, but we may be able to diſcover, when we come near to the Continent or Soundings in theſe Latitudes, by a Hydrometer ſwimming deeper, which may be

be depended on; if that light Colour, which is observed in Sea-Water, when we approach Soundings, is caused by its being fuller of Pores; or, when it is considered that the extraordinary Heat, which is in the Sea-Water in the Winter, near these Coasts, is imbibed in the hotter Climates, to above a Mile deep. It is not improbable, but in the Winter, from the Beginning of *December* to the latter End of *March*, but the Sea-Water, when we come near, or into Soundings, may be something colder than in the same Latitude, at a good Distance from Land or Soundings. Now if it be so, we may discover by a Thermometer, when the Sea-Water becomes more cold; which may be of some Advantage in knowing when we are near Land, or in Soundings: But there can be very little said for either Way, 'till there is some Trial made thereof, by Way of Experiment.

P. S. Agreeable to what I apprehended from the Consistence of so many Appearances of Nature, favouring the Hypothesis of the Sea's having a Circulation; am since credibly informed, that there is a Current which sets to the S. W. off St. *Helena*: Consequently, as the Magnet of the *Cape of Good Hope* has a Variation of about one Degree in nine Years (according to the Account of the Learned Dr. *Halley*) it gives some Reason to expect, that if the Motion of that Magnet should be diligently observed by a Dipping-Needle for a great Number of Years, it may be found to approach nearer to the Equator.

F I N I S.